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Balancing Energy Consumption to Maximize Network Lifetime in Data-Gathering Sensor Networks

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Abstract:***Energy imbalance is a serious problem in wireless sensor network. This paper describes the various reasons for energy imbalance in wsn and different techniques to ensure energy efficient data transmission. It is characterized by multihop routing and difference in the responsibilities of different nodes. So because of different responsibilities, node dissipates their energy unevenly and result into energy holes. These energy holes result into network disconnectivity.So far so many different techniques has been proposed and some of them are exceptionally better than other, but on cost of some parameters and compromising with other parameters.***

Keywords: Multihop Routin, Adoptsmultihop, Balancing

I. INTRODUCTION

First of all, a wireless sensor network consists of a large no of nodes and they monitor a desired area, sense data, transmit that data to sink in multihop fashion or direct transmission. As the nodes in sensor networks are battery powered and they can't be recharged once they are down, energy should be used as efficiently as possible and that can be done only when every node will have evenly distributed responsibility. Basically there are two ways to send data to sink.

Sensor-to-sink direct transmission is the easiest way for reporting sensed data to the data sink if the transmissionrange of each sensor node is large enough to reach the sink.But the energy required to transmit data is directly proportional to the square of distance form sink. So in this mechanism the nodes far away from the sink will lose their energy more quickly comparing to the nodes nearer to the sink.

Opposite to this, node adoptsmultihop transmission technique in which nodes send data to sink via multihop path. In this approach the nodes that are nearer to sink will have to forward more data in comparison to the nodes that are far away from the sink. So the nodes near to the sink will lose more energy in comparison to nodes far from sink. Experimental results show that in multihop routing, when the nodes nearer to sink loose (finish) their energy , the nodes farthest away from sink had 90% initial energy remaining with them. So a new scheme named as mixed routing scheme was introduced. In this scheme, nodes alternate between hop by hop and direct transmission mode and a data distribution ratio is calculated for every node. According to the data distribution ratio node sends data in these two modes.

II. RELATED WORK

The schemes that have been given so far are as follows.
Cluster head rotation scheme: In this scheme some node acts as cluster head and node forwards data to them and these cluster head are changed periodically so that their energy can be saved. But changing of cluster heads must be performed very frequently so that every node will get a chance to become cluster head and this requires extra mechanism to perform rotation.

Non uniform deployment scheme: In this technique, additional nodes are deployed in the area where traffic is high compared to the area where the data traffic is low. But there is one problem with this scheme ie in the starting it is difficult to calculate where the traffic will be high or where it will be low.

Power adjusted transmission scheme: In this scheme node sends data according to the available energy with them. Before sending the data, their energy level is checked and if they have the energy more than the threshold, then only they will be selected to be used as the next hop for transmission. But the problem is that how to check their energy, an extra apparatus is required for that task.

Data aggregation technique: In this technique, node performs data aggregation before forwarding data to next node. Data aggregation is a process of eliminating redundant data. But this technique can not be used in the applications where data aggregation is not allowed to perform.

Sink node based scheme: According to the requirement, there are two options available known as single sink vs multiple sink. In single sink, there will be one sink and every node will send data to that sink directly or by multihop path according to their position. Whereas in multiple sink, there will be more than one sink and nodes will send data to the sink available in their region. One more type of sink option is available ie mobile sink in which the

sink node moves in the monitoring area and collects data from sensor nodes.

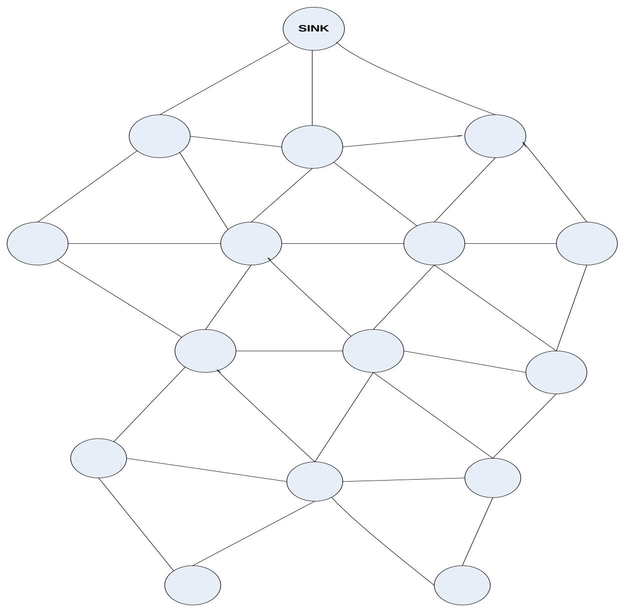
III. SYSTEM MODEL

In the model of the network, it isassumed that all sensor nodes are uniformly distributed in a monitoring area. There is only one sink in the network and the sink is static by nature. It is also assumed that each node can directly communicate with the sink. The data gathering operation is divided into rounds.

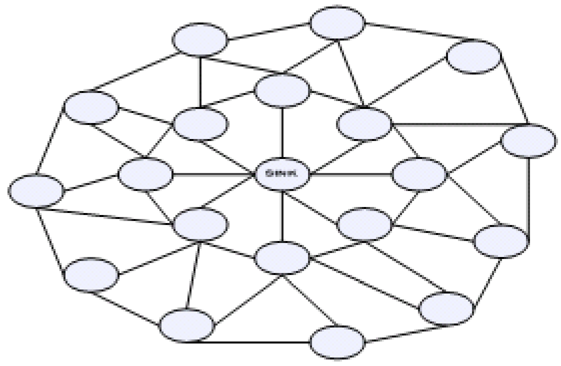
A general data collection model is employed in this study. In this model, the amount of data sent in different modes is a linear function of total data sensed by a node. The figure shows a network having some nodes and the distance of these nodes from the sink is different for different nodes. The graph for BFS algorithm will be constructed as follows.

For a particular distance *d*, all the nodes that will be in that distance *d*, an undirected edge will be considered between sink and that node. Now for any two nodes (u,v), an edge exists between u and v iff*d*(u,v) <*d*. According to this assumption, a graph has been drawn and sink is assumed to be the root of the graph. This distance *d* is not fixed and varies with the density of nodes in the network.

After running the BFS algorithm in the graph, considering starting node as sink, the level of different nodes are as follows. For this particular graph, some nodes are at level1, some are at level 2, etc.



SINK AT CENTRE:



IV. ENERGY BALANCING MECHANISMS

Energy Consumption model based on aggregation.

In this model, the amount of data outputted, denoted by E(x) = mx + c

1. If m=0 and c> 0 the model corresponds to a scenario in which each node can generate the data it receives . This case is suitable to applications with aggregation operations such as min or max (e.g., temperature and humidity), sum (e.g., event count), and yes-no (e.g., intrusion detection).

2.If 0 < m < 1 and c = 0, the model corresponds to the scenario in which all sensor nodes can compress the data they generate and receive by a factor of m.

3.If m =1 and c = 0, the model corresponds to the scenario in which all nodes do not perform any dataaggregation.

In this approach, the network is divided into circular regions and this type of structure is known as CORONA based network. There are two type of transmission modes that are used in alternate manner. Nodes forward some data in multihop fashion and some data in direct transmission mode. Now how much data will be send in which mode is different for different coronas. This is calculated by finding the node distribution ratio which is the ratio of data transmitted in direct transmission mode to the total data transmitted in both modes.

$$p(u) = \frac{D(u)}{F(u) + D(u)}$$

So the basic idea behind this model is that the energy can be balanced in nodes of Ci if and only if the data to be send is balanced among them. In this model, zone based routing scheme is adopted which is a good scheme to select a node to forward data that is nearer to sink but it also incurs extra cost how to implement this zone based routing scheme with in each corona as well as in the overall network.

According to the simulation results and the graphs obtained after simulation, it has been observed that it is a better scheme among all the available schemes so far to balance energy consumption in wireless sensor networks.

In this model the data distribution ratio for the nodes that are very nearer to sink is .60(for 2nd corona). So for this ratio(p), the data transmitted in direct transmission mode will be 1.5 times more than the data transmitted in hop by hop mode. It makes sense as the nodes that are closer to sink, for them the direct transmission is more energy efficient as the transmission distance is very less.

In opposite to this, the nodes that are in between the network, for them the data distribution ratio is 0.15 (for corona Id 10). Now the data transmitted in direct transmission mode is only upto 20% of the data transmitted in hop by hop mode. It also makes sense as the distance is now more in comparison to nodes near to sink, now hop by hop mode is more preferable over direct transmission to sink.

Again for the nodes that are very far from the sink ,there is some increase in data distribution ratio which is because at last corona the data to forward is less than to inner nodes.

CORONA ID	ρ(U)	D(U)
2	0.60	1.5F(U)
3	0.50	F(U)
4	0.30	.43F(U)
5	0.25	.33F(U)
10	0.15	.18F(U)
25	0.10	.12F(U)

So this scheme is better than all the previous schemes as here the nodes are having data to send in a balance manner.

V. PROPOSED SCHEME FOR ENERGY BALANCING

A. Basic Concept

Each node in the sensor network will be on a level and more than one node can be on the same level. Basically the level of a node will signify the distance of a node from the sink. The level of the sink will be zero and the levelof a node increases with the increase in the distance from sink. Itis also assumed that the sensor nodes are static and every node has same transmission power and every node can directly communicate with the sink at any time if required. In our proposed scheme, a new field named as level no of a node will be added in the header of the data packet sent by the node. When a node will send the data in hop by hop mode, this data will be received only by the nodes that are just on the previous level of the sender node. This will be achieved by comparing the level of the sender and receiver nodes. In our approach, after running the BFS algorithm in the network, every node knows its level. Basically it will ensure that the data send by a 2nd level node in the network will be received by only 1st level nodes. Without loss of generality it is assumed that every node in the network can send data to sink directly if required.

In this scheme, a node will transmit data in two transmission modes. One mode is hop by hop transmission mode and the other mode is direct transmission mode. In hop by hop transmission mode, a node sends data to the nodes that are on previous level whereas in direct transmission mode, node will send data directly to the sink.

- Let us assume that $L_i$be the level of a node that is on i^{th}level.
- The transmission range is ‘r’ for hop by hop transmission .
- The amount of data transmitted in direct transmission mode is denoted by D_d and data transmitted in hop by hop mode is D_h.
- The total amount of data generated by a node is denoted by *D.*

The amount of data to be transmitted in these two modes is calculated as follows.

- $D_d = \dfrac{D}{L_i}$
- $D_h = D - D_d$

B.Levelling of nodes

For the levelling of nodes, Breadth First Search(BFS) algorithm is used. BFS has a unique property that it divides the graph into levels and the edges in the BFS tree only corresponds to adjacent levels. Our approach also uses the property of BFS tree i.e the level of a node signifies the shortest distance in terms of hop by hop from the root. The BFS algorithm will give us the level of the nodes. The algorithm will start running from sink and the sink will be labelled as a node having level of zero(0). Then the nodes that are directly connected to the sink wil be labelled as level one nodes. The adjacent of level one nodes that have not been yet visited, will be labelled as2nd levelnodes. This process will keep on going until all the nodes get their level.

BFS Algorithm for levelling of nodes

Level no	D_d	D_h
1	*D*	0
2	.5*D*	.5*D*
3	.33*D*	.67*D*
4	.25*D*	.75*D*
5	.20*D*	.80*D*

```
BFS(G,s)
for each vertex u€ V[G] – {s}
    do color[u] ← WHITE
        d[u] ← infinite
        ∏[u] ← nil
color[s] ← GRAY
d[s] ← 0
∏[s] ← nil
Q←Ø
ENQUEUE(Q,s)
while Q ≠ Ø
    do u ← DEQUEUE(Q)
for each v € Adj[u]
            do if color[v] =  WHITE
                then color[v] = GRAY
d[v]=d[u]+1
                    ∏[v] ← u
                    ENQUEUE(Q,v)
color[u]←BLACK
```

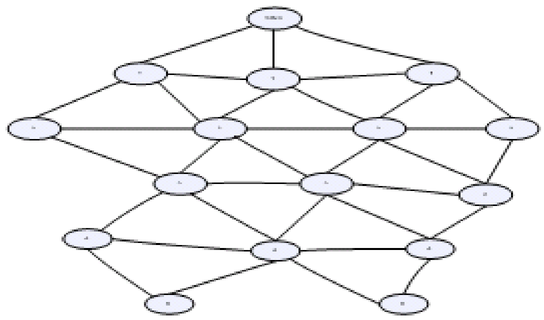
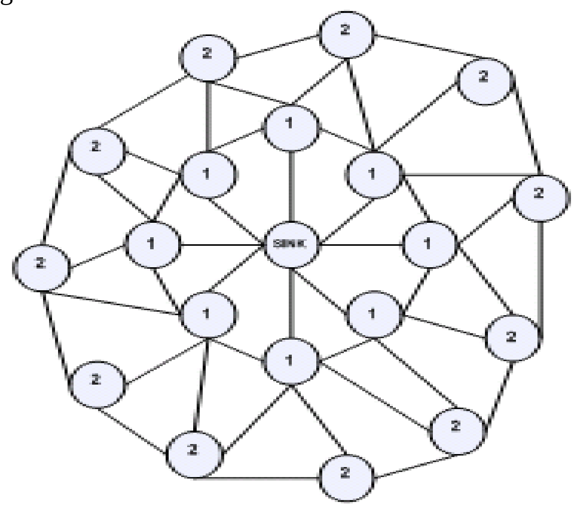


Fig. Division of Network into levels



The total no of levels in the graph is totally dependent on the distance *d* which is used to construct the graph before running the BFS algorithm. Basically the larger the *d*, lesser the no of levels in the graph and lesser the *d*, more no of levels in the graph.

REFERENCES

i. Crossbow, Mica2 Wireless Measurement System Datasheets, http://www.xbow.com/Products/Product_pdf_files/Wireless_pdf/ 6020-0042-04_A_MICA2.pdf, 2008.

ii. M. Bhardwaj, T. Garnett, and A.P. Chandrakasan, "Upper Bounds on the Lifetime of Sensor Networks," Proc. IEEE Int'l Conf. Comm. (ICC '01), pp. 785-790, 2001.

iii. J.-H. Chang and L. Tassiulas, "Maximum Lifetime Routing in Wireless Sensor Networks," IEEE/ACM Trans. Networking, vol. 12, pp. 609-619, 2004.

iv. C. Efthymiou,S. Nikoletseas, and J. Rolim, "Energy Balanced Data Propagation in Wireless Sensor Networks," Proc. 18th Int'l Parallel and Distributed Processing Symp. (IPDPS '04), p. 225a, 2004.

v. A. Giridhar and P.R.Kumar, "Maximizing the Functional Lifetime of Sensor Networks," Proc. Fourth Int'l Conf. Information Processing in Sensor Networks (IPSN '05), pp. 5-12, 2005.

vi. W.R. Heinzelman, A. Chandrakasan, H. Balakrishnan, Energy-efficient communicationprotocol for wireless microsensor networks, in: Proceedings of the33rd International Conference on System Sciences, HICSS'00, 2000.

vii. J. Hill, R. Szewczyk, A. Woo, S. Hollar, D. Culler, K. Pister, System architecturedirections for networked sensors, in: Proceedings of International Conferenceon Architectural Support for Programming Languages and OperatingSystems, ASPLOX-IX, 2000.

viii. C. Intanagonwiwat, R. Govindan, D. Estrin, Directed diffusion for wirelesssensor networking, IEEE/ACM Transactions on Networking 11 (1) (2003)2–16.

ix. X. Jiang, P. Data, D. Culler, I. Stoica, Micro power meter for energy monitoringof wireless sensor networks at scale, in: Proceedings of the 6th InternationalConference on Information Processing in Sensor Networks, 2007.

x. J-Sim, Available on: http://sites.google.com/site/jsimofficial (accessed8.01.10).

xi. G. Li, Y. Cao, X. Ago, J. Tang, Energy balance routing protocol for wireless sensornetworks based on fuzzy next-hop selection, Wuhan University. Journal ofNatural Sciences 14 (2) (2009) 148–152.

xii. P. Li, Y. Go, B. Zhao, A global-energy-balancing real-time routing in wirelesssensor networks, in: Proceedings of the 2nd IEEE Asia-Pacific ServiceComputing Conference, 2007

xiii. Y. Xu, J. Heidemann, and D. Estrin, "Geography-Informed Energy Conservation for Ad-Hoc Routing," Proc. ACM MobiCom, 2001.

xiv. V. Rodoplu and T.H. Men, "Minimum Energy Mobile Wireless Networks," IEEE J. Selected Areas in Comm., vol. 17, no. 8, pp. 1333-1344, Aug. 1999.

xv. W. Heinzelman, J. Kulak, and H. Balakrishnan, "Adaptive

xvi. Protocols for Information Dissemination in Wireless Sensor Networks," Proc. ACM MobiCom, 1999.

xvii. *W. Heinzelman, A. Chandrakasan, and H. Balakrishnan, "Energy-Efficient Communication Protocols for Wireless Micro sensor Networks," Proc. Hawaiian Int'l Conf. Systems Science, 2000.*

xviii. *A. Boukerche, X. Cheng, and J. Lanus, "Energy-Aware Data-Centric Routing in Micro sensor Networks," Proc. Sixth ACM Int'l Workshop Modeling Analysis and Simulation of Wireless and Mobile Systems (MSWIM' 03), pp. 42-49, 2003.*

xix. *O. Younis and S. Fahmy, "HEED: A Hybrid, Energy-Efficient Distributed Clustering Approach for Ad Hoc Sensor Networks," IEEE Trans. Mobile Computing, vol. 3, no. 4, pp. 366-379, Oct.-Dec. 2004.*